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EFFECT OF FERTIGATION ON SOIL CHEMICAL PROPERTIES, GROWTH AND NUTRIENTS CONTENT OF *BASELLA ALBA*

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Abstract
African countries that are naturally agriculture endowed but with low crop yield as a result of soil nutrients depletion and dry spells which does not encourage all year round crop production can only be transformed through fertigation. Fertigation combines application of water and fertilizer for crop production especially in the dry season. Hence, two field experiments were concurrently carried out at farmer's field in 2015 in Ondo, Southwestern Nigeria to compare the effect of fertigation on soil chemical properties, growth and nutrients content of Basella alba. 5 and 10 t/ha of poultry manure (PM), 22ml of foliar fertilizer (MF), 5 and 10t/ha PM combined with 11ml foliar fertilizer (2MF) and no fertilizer treatments were individually mixed with 6,000L of water/ha. The treatments were arranged in Randomized Complete Block Design and replicated three times. Compared with control, all the treatments significantly increased ($p < 0.05$) number of leaves and plant height of Basella alba. Poultry manure (PM) singly applied at 10 t/ha and PM and MF combined significantly ($p < 0.05$) recorded highest increase in crude protein, crude fibre, fat and moisture content of Basella alba as well as soil OC, total N available Ca, K, Mg, Cu and Zn.

***Keywords**: Maxiforce, soil nutrients, growth parameters, Basella alba*

Introduction
The bimodal climatic condition of Nigeria does not encourage all year round crop production. During the dry season, the land is difficult to till as a result of the hardness of the soil caused by shortage of water. Few farmers who have hydromorphic soils engage in arable farming during the dry season. The hydromorphic soil literary called fadama is not common in western Nigeria, and where available is too small for large vegetable cultivation. Shortage of water during the dry season is one of the bottlenecks that hinder all year round crop production. In order to avert food shortage, farmers need to find means of making water available for crop production during the dry season.

Another major problem facing crop production in Nigeria is the inherent poor soil fertility. Most of Nigerian soils are kaolinitic in nature with inherent low fertility (Adetunji *et al*., 2005). Hence, there is need to apply fertilizer. Fertigation could be used to curb the problem of water shortage for cropping and poor soil fertility. Fertigation aims at supplying water and plant nutrients to the soil where the soil suffers from lack of water and soil nutrients. Many farmers use mineral fertilizers to increase crop yield while few farmers use animal wastes as alternative to mineral fertilizer. Mineral fertilizers are costly and have acidic effect on soil at long run. Organic fertilizers are cheap, environmental friendly but the crop requires large quantity of organic wastes before

they can release adequate nutrients to the soil (Adeniyan and Ojeniyi, 2006). Combining low rate of mineral fertilizer with little quantity of organic fertilizer may likely solve the problems associated with its sole use and organic manures.

Basella alba is a vegetable that is rich in vitamins and minerals that could prevent many diseases. Its production during the dry season would equally serve as source of employment and as source of income during the dry season (Baynes, 1991). There is little or no known information on the effect of poultry manure mixed with water, maxiforce mixed with water or their combinations on soil properties and yield of crops. Hence, the objectives of this study were to compare the effect of water combined with poultry manure, maxiforce and their combinations on soil chemical properties, growth and yield of *Basella alba*.

Materials and Method
Two field experiments were carried in Okegun farm and Ondo South western Nigeria in 2015 to compare the effect of fertigation on soil chemical properties, growth and nutrient quality of *Basella alba*.

The land was cleared, ploughed, harrowed and pegged. Beds were made of 4m x 4m with a discard area of 1m apart. There were seven treatments replicated three times. All the treatments were mixed with 6,000L of water /ha. The treatments were: water applied without manure which served as control, water + 5t/ha poultry manure (W + 5PM), water + 10t/ha poultry manure (W +10PM), water + 11t/ha maxiforce (W+ 2M), water + 5t/ha poultry manure+ 11t/ha maxiforce (W +5PM+ 2FM), water + 10 t/ha poultry manure +11 t/ha maxiforce (W+10PM+2MF) and water + 22ml maxiforce (W +MF). Maxiforce is a foliar fertilizer that has the recommended dose of 22ml/ha for arable crops in Nigeria. The maxiforce applied at 22ml/ha served as control experiment. The seeds of *Basella alba* were sown in the nursery and transplanted to the plots after two weeks of sowing. Both poultry manure and maxiforce were mixed with water, measured into knapsack sprayer and then sprayed on the plants. The excess water was retained in the soil. Spraying with knapsack and watering can are simulation of what the subsistence farmers use because of inadequate fund to buy the necessary irrigation equipment. Weeding was carried out with the local hand held hoe at three weeks interval.

Agronomic data were collected on plant height, number of leaves per plant, and dry matter yield. The number of leaves was counted while the plant height was measured from the base of the plant to the tip. Leaves of *Basella alba* were harvested, weighed to get the fresh weight and finally oven dried to get the dry matter yield.

Before and after the experiments, soil samples were collected with auger to determine the nutrient status of the soil and the amount of nutrients retained in the soil after treatments application. This would indicate the amount of nutrients retained for the incoming crops. . Soil pH was determined using class electrode 1:2 soil:water ratio, nitrogen was determined by Microckjedahl method, organic matter was determined by using the method of Walkely and Black, (1932), and available phosphorus was extracted with Bray – 1- method (Bray and Kurtz, 1945) and determined colourimetrically. Exchangeable calcium, magnesium and potassium were extracted with ammonium acetate. Calcium and Mg were read with Atomic Absorption Spectrophotometer (AAS) while K was read with photometer.

Data Analysis

Descriptive statistics (tables, means and figures) were used to analyze the data for the two experiments. Also the data were subjected to One Way Analysis of Variance and means were separated by Duncan Multiple Range Test.

Result and Discussion

The soil samples of the two locations were collected separately analysed and their means were used to discuss the results since the results from the two locations were similar. The initial soil properties used for the conduct of the experiments showed that the soils were slightly acidic, low in OC, N, available P, Ca and Mg (Agboola and Sobulo, 1981, Akinrinade and Obigbesan, 2000, Ayeni, *et al*., 2015). The low nutrients status of the composite soils showed that the soils were not fertile for optimum production of *Basella alba,* hence, needed external source of plant nutrients. *Basella alba* requires considerable amount of plant nutrients (Okubena-Dipeolu, 2015).

Table 1:Mean values of initial soil chemical properties at the two sites

Soil properties	value
pH	5.60
OM%	1.12
N%	0.09
Available P (g/kg)	5.78
Ca C mol/kg	1.25
Mg ,,	0.93
K ,,	0.54
Micronutrients (mg/kg)	
Fe	11.23
Cu	0.60
Zn	6.78
Mn	7.23

Foliar fertilizer (maxiforce) is NPK 20:20:20 in liquid form according to the manufacturer's label. Poultry manure used for the experiment comprised 2, 10.42, 18.45 and 1.71% for N, P, K, Ca and Mg respectively. This showed that maxiforce would add more N, P and K to the soil than the poultry manure. Poultry manure comprised reasonable amount of cations which might assisted in balanced plant nutrition as all the nutrients are essential for the optimum crop production. Ayeni and Adetunji. (2010) affirmed that poultry manure add both macro and micro nutrients to the soil that could be of benefit to crops.

The effect of fertigation of single application of poultry manure, maxiforce and their combinations is presented in Table 2. Compared with control, all the treatments significantly increased ($p< 0.05$) plant height, number of leaves and dry matter content of Basella alba. Application of W + 10PM + 2MF recorded the highest plant height, W + 10PM + 2PM recorded the highest dry matter content of *Basella alba* while W + MF recorded the highest number of leaves. The highest increases in Basella fertilized with poultry manure, maxiforce and their combinations over the control experiment clearly showed that the treatments added nutrients to the soil for Basella uptake. This is in line with the work of Ayeni et al. (2013) that poultry manure increased the growth and yield of *Basella alba*. It was also observed that the Basella treated with either full recommended dose of maxiforce (W + MF), half recommended dose of maxiforce singly applied or combined with poultry manure recorded the highest vegetative growth of *Basella alba*. This might be a result of the higher N, P and K concentration of maxiforce than poultry manure. Also, maxiforce was already in liquid form while poultry manure was in solid form before they were dissolved in water and after their dissolution, poultry manure still had some particles undissolved. It was likely for the nutrients in maxiforce to mineralize earlier than the poultry manure.

Table 2: Mean effect of water mixed with poultry manure, maxiforce and their combinations on growth parameters of *Basella alba*

Treatment	plant height (cm)	Dry matter (%)	No of leaves
control	4.27c	83b	32.68e
W+5PM	6.37b	94a	93.68c
W+10PM	6.67b	93a	67.45d
W+MF	6.25b	99a	129.87a
W+ 2M	5.99b	93a	119.29b
w+5PM+2MF	5.68b	100a	108.00b
W+10PM+2MF	7.49a	97a	134.00b

Means with the same letter are not significantly different using Duncan Multiple Range Test at 5%
NB: Water only = control, W + 5PM = water + 5t/ha poultry manure, W +10PM = water + 10t/ha poultry manure, W+ 2M = water + 11t/ha maxiforce, W +5PM+ 2MF = water + 5t/ha poultry manure + 11 t/ha maxiforce., W+10PM+2M) = water + 10 t/ha poultry manure +11 t/ha maxiforce, water + 22ml maxiforce (W +MF).

Table 3 presents the effect of fertigated poultry manure, maxiforce and their combinations on the nutritive value of *Bassala alba*. Relative to control, all the treatments significantly increased crude protein, crude fibre, total ash except w +5PM and carbohydrate. Application of W + 10PM + 2MF recorded the highest crude protein, crude fat, moisture content and crude carbohydrate. This work is in line with Makinde et al. (2010) and Okubena-Dipeolu, (2015) that organic manures increased the nutrient quality of *Basella alba* in the experiment conducted on the nutrient quality of and sensory evaluation of *Amaranthus cruentus* in Luvisol. Magkos et al. (2003) also affirmed that vegetables grown with organic manure had higher nutritional quality than vegetables grown with mineral fertilizers.

Table 3: The effect of water mixed with foliar fertilizer, poultry manure and their combinations on nutritional quality of *Basella alba.*

Treatment	C. Protein	C.Fat	C. Fibre	Total ash	Moisture	NFE
control	16.80b	3.02c	17.40a	12.22b	10.47a	32.31b
W+5PM	18.48a	4.77b	20.24a	13.76ab	10.73a	43.27a
W+10PM	18.94a	4.17b	22.17a	14.19a	10.53a	40.57a
W+MF	20.72a	4.06b	20.01a	14.12a	11.55a	42.63a
W+ 2M	17.23ab	4.07b	23.12a	14.07a	10.51a	37.76a
w+5PM+2MF	20.21a	5.13a	20.12a	13.70a	11.16a	36.63a
W+10PM+2MF	21.32a	5.62a	21.13a	13.93a	12.17a	43.87a

Means with the same letter are not significantly different using Duncan Multiple Range Test at 5%
NB: Water only = control, W + 5PM = water + 5t/ha poultry manure, W +10PM = water + 10t/ha poultry manure, W+ 2M = water + 11t/ha maxiforce, W +5PM+ 2MF = water + 5t/ha poultry manure + 11 t/ha maxiforce., W+10PM+2M) = water + 10 t/ha poultry manure +11 t/ha maxiforce, water + 22ml maxiforce (W +MF).

The effect of fertigation of poultry manure, maxiforce and their combinations on soil chemical properties after the harvest of *Basella alba* is shown in Table 3. Compared with control there was significant changes in soil pH with the plots treated with poultry manure and poultry manure combined with maxiforce. There was no significant difference in the pH of the soil treated with maxiforce. The increase in the pH of the soil treated with poultry manure and its combination with maxiforce might be as a result of Ca and Mg present in poultry manure which was absent in maxiforce. Many research works have shown that adding Ca to the soil raises the pH level of soils (Ayeni *et al*., 2008, Makinde *et al*., 2010, Agboola *et al*., 1992). This buttressed the liming effect of poultry manure. The low pH recorded by the plots treated with maxiforce at the full or half recommended dose might be as a result of lack of Ca in its constituents because Ca is known to raise soil pH. The experiment conducted by Ayeni et al (2008) showed that the high amount of Ca in cocoa pod ash increase soil pH. Maxiforce might have been manufactured from acidic materials or medium because most mineral fertilizers are produced from acidic medium. The results obtained for Ca in Table 3 showed that poultry manure added more Ca to the soil than maxiforce.

Compared with control, all the treatments significantly increased soil OC (except W+2 MF)), total N, available P (except W +2MF), exchangeable K except (W + 5PM) Mg and Zn (W + 5PM). Application of 10t/ha poultry manure combined with 11 ml Maxiforce/ ha dissolved in water had the highest increase in soil pH, OC, total N, available P, exchangeable Mg, Cu, Zn and Fe. The better release of the essential nutrients into the soil by poultry manure with or without combination with maxiforce buttressed the fact that poultry manure is suitable organic materials that could be used to improve soil fertility.This is in line with the work of Ayeni and Adetunji. (2010), who observed that poultry manure is a source of macronutrients and organic carbon. Poultry manure and its combinations with maxiforce had higher OC than its corresponding maxiforce applied in single form, though, no significant difference was recorded. It was also observed that maxiforce increased soil Zn (except W + MF and W + 2MF) despite the fact that it contained only N, P and K in its formulation. This might be as a result of inherent soil Zn and Fe present in the soil. Micronutrients release is enhanced by low soil pH. Brady and Weil,(1999) observed that the presence of micronutrients in soil enhance the reduction in soil pH.

The moisture state of the soil could also influence the release of plant nutrients especially the micronutrients. Addition of water to the soil is known to enhance mineralization of N, P and micronutrients present in the soil. Compared with control, all the treatments significantly increased total N, available P, exchangeable K, Ca and Mg except W + MF and W + 2MF. This clearly shows that poultry manure has better residual effect on soil chemical properties than maxiforce. The better residual effect of PM on soil chemical properties than maxiforce might be as delay

in its nutrient mineralization. Though maxiforce had higher N, P and K content than poultry manure yet it recorded lower N, P and K compared with control. This might be as a result of leaching or nutrient evaporation because the experiments were conducted during the dry season. The higher Ca and Mg released into the plots fertilized with poultry manure might be as a result of the nutrients present in poultry manure

Table 4: The effect of poultry manure mixed with water, maxiforce mixed with water and their combinations on soil chemical properties

Treatment	pH	OC	N	P	K	Ca	Mg	Cu	Zn	Fe
			%	mg/kg		C mol/kg			mg/kg	
control	5.38b	1.14b	.10b	5.62c	.53c	1.22b	.80c	.69b	6.67b	9.10b
W+5PM	5.57b	1.73a	.13a	7.92b	.93b	2.24b	1.11b	.73b	8.90b	10.34b
W+10PM	6.75a	1.78a	.15a	9.92b	1.13a	4.52a	1.32a	.73b	13.40a	10.50b
W+MF	5.60b	1.34b	.15a	11.13a	1.14a	1.19b	.73b	.53b	14.72a	12.00b
W+ 2M	5.60b	1.16b	.13b	5.66c	.70b	1.20b	.83b	.51b	8.10b	19.40a
w+5PM+2MF	5.67b	1.51a	.16a	10.72a	1.32a	4.67a	1.45a	1.13a	15.43a	11.00b
W+10PM+2M	6.71a	1.53a	.17a	12.00a	1.33a	4.72a	1.54a	1.27a	14.00a	12.00b

Means with the same letter are not significantly different using Duncan Multiple Range Test at 5%
NB: Water only = control, W + 5PM = water + 5t/ha poultry manure, W +10PM = water + 10t/ha poultry manure, W+ 2M = water + 11t/ha maxiforce, W +5PM+ 2MF = water + 5t/ha poultry manure + 11 t/ha maxiforce., W+10PM+2M) = water + 10 t/ha poultry manure +11 t/ha maxiforce, water + 22ml maxiforce (W +MF).

Conclusion and Recommendation

Two experiments were carried out to compare the effect of water, water combined with either poultry manure or maxiforce and their combinations in Ondo, Southwestern Nigeria during the dry season. Poultry manure and maxiforce mixed with water increased the growth parameters of *Basella alba.* Poultry manure singly applied and poultry manure mixed with maxiforce applied both 5 and 10 /ha recorded the highest soil chemical properties after the conduct of the experiment. Fertigation could be used to grow *Basella alba* in the soil that is water deficient and in the depleted soil.

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